International Journal of Information Management 36 (2016) 917–928

Contents lists available at ScienceDirect

International Journal of Information Management

journal homepage: www.elsevier.com/locate/ijinfomgt

Big data reduction framework for value creation in sustainable enterprises

Muhammad Habib ur Rehman[a,*], Victor Chang[b], Aisha Batool[c], Teh Ying Wah[a,*]

[a] Faculty of Computer Science and Information Technology, University of Malaya, KL, 50603, Malaysia
[b] Suzhou Business School, Xi'an Jiaotong Liverpool University, Suzhou, China
[c] Department of Computer Science, Iqra University, Islamabad, Pakistan

ARTICLE INFO

Article history:
Received 11 May 2016
Received in revised form 14 May 2016
Accepted 14 May 2016

Keywords:
Sustainable enterprises
Value creation
Big data analytics
Data reduction
Business model

ABSTRACT

Value creation is a major sustainability factor for enterprises, in addition to profit maximization and revenue generation. Modern enterprises collect big data from various inbound and outbound data sources. The inbound data sources handle data generated from the results of business operations, such as manufacturing, supply chain management, marketing, and human resource management, among others. Outbound data sources handle customer-generated data which are acquired directly or indirectly from customers, market analysis, surveys, product reviews, and transactional histories. However, cloud service utilization costs increase because of big data analytics and value creation activities for enterprises and customers. This article presents a novel concept of big data reduction at the customer end in which early data reduction operations are performed to achieve multiple objectives, such as (a) lowering the service utilization cost, (b) enhancing the trust between customers and enterprises, (c) preserving privacy of customers, (d) enabling secure data sharing, and (e) delegating data sharing control to customers. We also propose a framework for early data reduction at customer end and present a business model for end-to-end data reduction in enterprise applications. The article further presents a business model canvas and maps the future application areas with its nine components. Finally, the article discusses the technology adoption challenges for value creation through big data reduction in enterprise applications.

1. Introduction

Research shows that 90% of enterprises fail, and that one of the key failure factors is invaluable products and services that do not meet customer expectations (Patel, 2015). A market research on 135 failed startups reveals that 42% of failures occurred because the products and services did not meet the market needs, 17% failed because of the lack of business models, and 14% of the enterprises failed because they ignored their customers (Insights, 2016). Therefore, enterprises must consider maintaining the right product development for the right customers at the right time, have a well-defined business model for revenue generation and profit maximization, and re-evaluate and customize their products and services according to customer requirements (Patel, 2015). Considering these facts, this article addresses the issue of value creation to create sustainable enterprises.

The adoption of Internet of Things (IoTs), big data, and cloud computing technologies by enterprises has led to better value creation at the customer and enterprise ends (Haile & Altmann, 2016; Mital et al., 2016). Value creation for the customer, called value to the customer (V2C), is the process of understanding customer needs and offering them products while considering the competitive advantage over rival enterprises (Cossío-Silva, Revilla-Camacho, Vega-Vázquez, & Palacios-Florencio, 2015; Verhoef, Kooge, & Walk, 2016). Value creation for enterprises, otherwise called value to firm (V2F), is the process of searching for pitfalls inside enterprise operations and optimizing business process models accordingly (Qi, Qu, & Zhou, 2014). Big data analytics is becoming a key driver of value creation in modern enterprises, wherein enterprise applications are designed to collect direct customer feedback and information from internal business operations (Verhoef et al., 2016). The collected data streams are analyzed using a six-step big data analytic process that continuously evolves to meet the business dynamics and customer requirements. However, the acquisition of big data analytic services from cloud service providers increases financial burden on enterprises, which may lead to the failure of small and medium-sized enterprises (Verhoef et al., 2016).

* Corresponding authors.
E-mail addresses: mhrehman@siswa.um.edu.my, habibcomsats@gmail.com (M.H.u. Rehman), tehyw@um.edu.my (T.Y. Wah).

http://dx.doi.org/10.1016/j.ijinfomgt.2016.05.013
0268-4012/

The main contribution of this article is the concept of early data reduction at the customer and enterprise ends to reduce big data and achieve V2C and V2F objectives. The article presents the background of big data, cloud computing, and IoTs for enterprises to assist readers who may not be familiar with these concepts. A review of the big data analytic process and popular relevant tools for value creation is also provided. The article also presents a novel framework for early data reduction at the customer end wherein the analytic-driven data reduction approaches convert raw data streams into actionable knowledge patterns. The article presents a hypothetical business model to achieve the V2C and V2F objectives of enterprises. Finally, the article presents the business model canvas and maps 10 potential application areas on the business model canvas.

1.1. Big data for enterprises

Big data is defined as the set of structured, unstructured, and semi-structured data accumulated from heterogeneous data sources (Yaqoob et al., 2016). Conventionally, big data are presented in terms of 3 Vs namely, (i) volume, (ii) velocity, and (iii) value. Volume represents the size of the data whereas velocity represents the speed of data that is entering into big data systems. The value property of big data determines its usefulness to take actionable decisions after data analysis. However, big data is currently redefined with the addition of three new Vs: (i) variety, (ii) variability, and (iii) veracity (Rehman & Batool, 2015; Gani, Siddiqa, Shamshirband, & Hanum, 2016). The variety property defines the multi-facet big data integrating with the different data types generated by various data sources. The variability property determines the internal variability in big data with multiple 'information shifts' as time passes. The information shift is defined as the difference between states of knowledge in big data systems. The veracity property shows that big data are collected from authentic and reliable data sources.

Despite considering the three basic Vs of big data, enterprises are adopting big data systems for innovative business models. Modern enterprises collect massive amounts of data from various direct and indirect sources to uncover hidden knowledge patterns and optimize the business process models (Gandomi & Haider, 2015). The direct data sources in enterprises generate operational information relevant to supply chain management, production, fleet management, marketing strategies, behavior analysis of employees, etc. Indirect information includes data collection from click streams, ambulation activities, geo-location information, health records, and many other types of customer-relevant data. Currently, most enterprises collect indirect data from third-party data providers, such as database marketers or market analysis firms. This strategy increases the operational cost of big data systems and creates serious privacy threats, resulting in customer churn and lowering the enterprises' profits. Therefore, variability, veracity, and variety properties of big data require serious attention, particularly in terms of direct data collection to build trust between enterprises and customers.

Big data help enterprises in profit maximization by optimizing business process models for V2C objective (Vera-Baquero, Colomo-Palacios, & Molloy, 2013). To this end, enterprises use big data mainly for market analysis, customers' segmentations, and personalization. For example, enterprises collect social media data streams such as that provided by Twitter, Facebook, and YouTube. Similarly, enterprises acquire data from e-commerce websites to analyze customers' feedbacks and online product reviews. Big data are also used to perform segmentation of market data to optimize business process models. For example, customer segmentation can assist enterprises in offering products and services to a specific group of customers with similar characteristics. Moreover, big data can also aid in uncovering customer behaviors that enable the design of recommender systems that meet the personal needs of each customer. For example, enterprises analyze click streams of web browsers to uncover customer behaviors and recommend products and services accordingly.

Enterprises use big data to improve the internal business processes to achieve V2F objectives (Vidgen, 2014). On the production side, analysis of machine log files helps in improving the lifetime of machinery and other equipment. Similarly, big data acquired from supply chain management systems help in improving delivery time of products and services. The analysis of big data acquired from employee management systems assists in formulating better and competitive salary plan to retain productive employees. Enterprises integrate big data from multiple internal data sources to improve the overall business models. Big data help in increasing V2F in numerous perspectives; however, uncovering actionable knowledge from big data is a significant challenge that requires laborious efforts to meet value creation objectives.

1.2. Cloud computing for enterprises

Cloud computing is the provision of computational, networking, and storage resources to lessen the operational and financial burden of maintaining large-scale computing systems. Cloud computing service providers offer a plethora of services that enable enterprises to deploy business applications and benefit from large scale powerful data centers (Chang, 2014; Sharma et al., 2016). The typical infrastructure of a cloud computing system has three layers: (i) infrastructure, (ii) platform, and (iii) application layer (Chang, Walters, & Wills, 2013). Cloud service providers offer services through all three layers. For example, they provide compute-only services through the infrastructure layer, virtualized platform for application deployment at the platform layer, and generalized application services at the application layer.

Enterprises adopt cloud computing systems to run their business applications optimally and efficiently. The adoption of cloud computing platforms for big data processing is increasing and many new cloud service providers offer big data processing services for enterprises. Big data processing models require huge amounts of computational, networking, and storage resources. Therefore, the adoption of cloud computing technologies for small- and medium-sized enterprises continues to be a challenge because of the high cost of service utilization. Cloud computing technologies can help enterprises in achieving V2C and V2F objectives for profit maximization (Chou, 2015). Cloud computing systems offer a high level of service availability as compared to in-house computing infrastructure, which could increase customers' trust. Alternatively, the enterprises do not need to worry about technology management and instead can focus on product development, customer retention, and operational activities (Chang & Wills, 2016).

1.3. IoTs for enterprises

IoTs are key drivers for profit maximization through value creation in sustainable enterprises. IoTs systems interact with physical environments to collect useful behavioral and operational information and optimize business process models (Li, Darema, & Chang, 2016). IoTs also enable enterprises to achieve V2C and V2F objectives (Pang, Chen, Han, & Zheng, 2015). For V2C, IoTs aid in optimizing business processes and offering efficient services. For example, IoTs in retail stores help to minimize queuing time for customers. Similarly, IoTs enable shoppers to interact with products to maximize customer retention and build trust. For V2F, IoTs help in optimizing enterprise operations, such as manufacturing processes, supply chain management, and retail operations, to name a few. However, the adoption of IoTs by enterprises has